

DEPARTMENT OF MECHANICAL ENGINEERING & MECHANICS
COLLEGE OF ENGINEERING & TECHNOLOGY
OLD DOMINION UNIVERSITY
NORFOLK, VIRGINIA 23529

**VISCOUS FLOW SIMULATIONS OF INTERNAL
STORE CARRIAGE AND SEPARATION**

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By

Oktay Baysal, Principal Investigator

Final Report

For the period ended May 15, 1991

Prepared for

National Aeronautics and Space Administration

Langley Research Center

Hampton, Virginia 23665

Under

Research Grant NAG-1-664

David S. Miller, Technical Monitor

AAD-Super/Hyper Aerodynamics Branch

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VISCOUS FLOW SIMULATIONS OF INTERNAL STORE CARRIAGE AND SEPARATION

**Oktay Baysal
Old Dominion University
Norfolk, Virginia**

The internal carriage of stores by the military aircraft is an option for possible reductions in the aerodynamic drag and the observability. Trade studies of this option require considering the aircraft and the stores together. In an effort to develop a Computational Fluid Dynamic (CFD) code for such studies, an investigation has been conducted from 1986 to 1990 with the support of NASA Grant NAG-1-664.

The study was divided into five building-block steps. First, a full-Navier-Stokes code was developed to simulate the unsteady, three-dimensional cavity flows (a two-dimensional investigation of the cavity flows had previously been conducted in 1985-1986 under the preceding NASA Grant NAG-1-559). The open cavity flows (deep cavity), the closed cavity flows (shallow cavity), and the transitional cavity flows have been studied. The effects of a large yaw angle on the full-span cavity flow and the aeroacoustic environment of the cavities have also been investigated. Although most of the flows were supersonic, one transonic and one subsonic

flow cases have been included. An additional support for these two cases were made possible through a NASA cooperative agreement NCC-1-121.

As the second step, this code was then used to simulate the flows past various missile configurations at angles of attack up to 44° . The effects of incidence as well as the turbulence on the leeside flows were computationally captured.

The objective of this study has involved the interference flows of rather complex configurations with multiple, joint or disjoint, components of nonsimilar geometries. Hence, a hybrid domain decomposition (HDD) method was developed as the third step of the investigation. The strengths of the multiblock, zonal, and overlapped grids were judiciously combined employed for the present problem.

In the fourth step, the interference flow past a missile near a flat-plate-wing has been simulated using the HDD method. Finally, the fifth step involved the simulation of the internal store carriage and separation. Four different cases for two different configurations have been simulated. The computational results of all five steps have been successfully compared with the available wind-tunnel test data. The unsteady aerodynamic forces on the separating store have been computationally predicted.

The CFD code developed for this project is called Viscous Internal Store Carriage Code (VISCC). The code is rather general in its capability to simulate flows past complex configurations. It has been requested and used for a multitude of flow simulations by a number of branches of NASA Langley Research Center, various aerospace companies, and various research laboratories of Department of Defense.

Abstracts of the accomplishments at various stages have been reported in the 1988–1990 Research and Technology Reports of NASA Langley Research Center. Details of the project and its results have been presented in various national conferences as well as through NASA

briefings. Their written versions have been published in various national journals, conference proceedings and pamphlets, and as contractor reports. Their list is given below. Also, two Ph.D. dissertations and two Master of Science theses have been produced based on the findings of this project.

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